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Production of tamarind seedlings with organic substrates and application of swine biofertilizer

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Abstract

The tamarind tree is a fruit tree that is quite resistant to tropical climates, making it easy to adapt to the Northeast. Substrates and biofertilizers, as they are organic materials and rich in micro and macronutrients, can enrich the soil for better cultivation of this plant. This research aimed to evaluate the growth of tamarind seedlings using different substrates and applying swine biofertilizer. The experiment was carried out from April to December 2023 at the Instituto Federal da Paraíba, Campus – Sousa-PB, adopting a completely randomized experimental design, with seven replicates, in a 7 x 2 factorial, referring to seven combinations of substrates, being: soil (control treatment), soil + cattle manure, soil + sheep manure, soil + chicken litter, soil + cattle manure + sheep manure, soil + cattle manure + chicken litter, soil + sheep manure + chicken litter, in the absence and presence of swine biofertilizer, totaling 98 experimental units. When the seedlings reached 40 days after sowing (DAS), the following were measured: seedling height (AM), stem diameter (DC), number of leaves (NF), root dry mass (MSR), shoot dry mass (MSPA), root to shoot ratio (RPA), and root length (CR). The best combination of substrates for seedling production was soil + cattle manure + chicken litter. The application of swine biofertilizer to tamarind seedlings promoted beneficial effects on stem diameter, thus making seedlings stronger and more resistant.

Keywords: fruit growing, manure, swine waste, *Tamarindus indica*

Introduction

In Brazil, tamarind (*Tamarindus indica*) is a fruit consumed especially in the north and northeast regions due to the climate that favors its production (Menezes et al., 2022). Tamarind is a tropical fruit native to Africa. Its pulp is acidic and sweet, used in cooking, beverages and traditional medicine. Rich in vitamins, minerals and antioxidants, tamarind is appreciated for its health benefits.

Tamarind seedlings are essential for the propagation of this fruit tree, which has great economic and ecological importance, being widely used in cooking, especially in tropical countries, and its fruits are rich in nutrients; in addition, the tamarind tree contributes to environmental sustainability, providing shade, improving soil quality and serving as a habitat for several species (Dutra & Oliveira, 2020).

An essential element for producing high-quality seedlings is the selection of the substrate, especially the choice of the components used in its formulation, considering the crop to be cultivated (Oliveira et al., 2017). Since the substrate that matches a given crop provides quality, yield and practicality in the production of seedlings, the seedlings will show vigor, quality development, and will have a certain resistance to the stresses that the crop may suffer, it can also develop increased productivity and lower the time for the beginning of its production (Jorge et al., 2020).

According to Paim et al. (2022), in addition to the substrates, another important factor is fertilization, which is crucial for the healthy development of seedlings, providing the necessary nutrients for their vigorous growth, improving the plants' resistance to diseases and pests, in addition to promoting a strong root system, resulting in more robust seedlings ready for transplantation.

One of the technical alternatives related to

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fertilization is the use of biofertilizer in agriculture, such as swine biofertilizer, a source of a wide range of nutrients, which aims to increase the sustainability of forage production, in addition to improving physical properties, such as soil structure and aeration and biological characteristics, promoting greater microbial activity and increasing the organic matter content in the surface layers of the soil (Moreira, 2013).

Today's agriculture faces challenges such as climate change, water scarcity, soil degradation and resistant pests. To combat these challenges, it is crucial to adopt sustainable agricultural practices such as crop rotation and agroforestry, as well as investing in technology for efficient irrigation and crop monitoring. The use of natural biofertilizers and the implementation of soil conservation techniques are also important, and supporting research and development of more resistant seeds and ongoing education of farmers can increase the resilience of the sector (Vasconcelos et al., 2019).

Due to the scarcity of studies involving the production of tamarind seedlings, the present study aimed to evaluate the growth of tamarind seedlings using different substrates and applying swine biofertilizer as a form of fertilizer.

Materials and Methods

The experiment was conducted adopting a completely randomized experimental design, with seven replicates, in a 7 x 2 factorial, referring to seven combinations of substrates, being: T1 soil (control treatment), T2 soil + cattle manure, T3 soil + sheep manure, T4 soil + chicken litter, T5 soil + cattle manure + sheep manure, T6 soil + cattle manure + chicken litter, T7 soil + sheep manure + chicken litter, in the absence and presence of swine biofertilizer, totaling 98 experimental units.

The soil used in the experiment was collected in the 0 to 20 cm layer in an area located on the IFPB campus. The substrates used were purchased from the agricultural farm. A sub-sample was taken from the soil and substrate samples were used to fill the polyethylene bags for chemical analysis. The experimental units were composed of 4 dm^3 polyethylene bags.

The swine biofertilizer was produced in the institution itself through anaerobic fermentation in a biodigester, i.e., in a hermetically sealed environment. Only swine waste (manure) was used for preparation. After this period, the biofertilizer was filtered and stored in PET bottles (Silva et al., 2012). The biofertilizer was diluted in water at 5% and applied 15 days after emergence (DAE), at five-day intervals, totaling four applications at a dosage of 10% of the volume of the substrate contained in the container, i.e., 10 mL per seedling.

For sowing, tamarind fruits from extractive-grown matrices were collected directly from trees, pulped manually, and the seeds were extracted. After extraction, the seeds were washed in running water and dried in the shade on paper towels for 24 h. Five seeds were sown in a polyethylene bag filled with substrates, at a depth of 3 cm. After seven days of emergence, thinning was done, leaving only one seedling per container until 40 days after emergence.

The experiment was irrigated daily with water supplied by the Institute itself, from the São Gonçalo Reservoir. A sample of the water used for irrigation of the treatments was collected for chemical analysis, which was performed at the Soil and Water Analysis Laboratory of the Federal Institute of Education, Science and Technology of Paraíba, IFPB – Sousa Campus.

The growth and development of tamarind seedlings was evaluated through two assessments: the first assessment 20 days after emergence (DAE) and 40 days after emergence, based on: seedling height (AM), stem diameter (DC), number of leaves (NF), shoot dry mass (MSPA), dry mass of stem (MSC), dry mass of root (MSR), total dry mass (MST), root and shoot ratio (RPA) and root length (CR).

The height of the seedling (cm) was obtained by measuring the distance between the collar and the apex of the seedling; the stem diameter (mm) was measured two centimeters above the surface of the substrate with the aid of a caliper; the number of leaves (units) was measured by manual counting; for the dry mass of the leaf, dry mass of the stem and dry mass of the root, these were separated and stored in properly identified paper bags and placed to dry in a forced ventilation oven at a temperature of 60 °C until a constant mass was obtained, then the weight was taken on a precision scale.

The data obtained were subjected to analysis of variance (ANOVA), followed by the Tukey test for substrate factor, at a significance level of 1% and 5% using the R statistical software.

Results And Discussion

Table 1 shows that there was a significant difference in the substrate x biofertilizer interaction only for root dry mass and shoot dry mass. The substrate significantly influenced most of the variables analyzed, except for stem diameter at 30 and 40 days after emergence. Meanwhile, the swine biofertilizer had a significant effect only on stem diameter and shoot dry mass at 20 days after emergence.

Table 1: Analysis of variance of tamarind seedlings under application of swine biofertilizer according to substrate types. AM: seedling height; DC: stem diameter; NF = number of leaves; MSR: root dry mass; MSPA: shoot dry mass; RPA: root shoot ratio and CR: root length, 20 and 40 days after emergence, respectively.

Source of variation	GL	Mean Squares				
		AM20	AM40	DC20	DC40	NF20
Substrate (S)	6	29.15*	52.89*	0.0017ns	0.0016 ns	6.13*
Biofertilizer (B)	1	29.25ns	63.68 ns	0.0057*	0.0082 ns	2.29 ns
S x B	6	10.60 ns	12.54 ns	0.0012ns	0.0009 ns	0.84 ns
CV	-	16.81	17.30	18.30	14.37	21.08
		Mean Squares				
		NF40	MSR	MSPA	RPA	CR
Substrate (S)	6	33.02**	0.17**	0.27**	0.379*	195.74*
Biofertilizer (B)	1	0.50 ns	0.033 ns	0.31*	0.017 ns	27.05 ns
S x B	6	3.07 ns	0.031*	0.05*	0.018 ns	8.97 ns
CV	-	22.90	26.76	21.02	30.45	23.97

ns= not significant, **= significant at 1% and *= significant at 5%, respectively.

Figure 1 shows the height of tamarind tree seedlings in different treatments, which showed a significant effect (p<0,05). At 20 days after emergence (Figure 1A), it was noted that the substrates: soil + cattle manure (T2), soil + cattle manure + sheep manure (T5), and soil + cattle manure + chicken litter (T6) promoted the highest values in seedling height, with 16.39; 16.85 and 18.39 cm, respectively. At 40 days after emergence (Figure 1B), seedlings grown in substrates T2 and T6 obtained the highest values, with 24.27 and 26.75 cm, respectively.

As shown in T6, which used soil + cattle manure + chicken litter, chicken litter used in smaller quantities recorded better development.

According to Silva et al. (2017), chicken litter, composed of bird droppings mixed with bedding material such as sawdust or straw, is a valuable organic fertilizer in agriculture, rich in nutrients such as nitrogen, phosphorus and potassium, it improves soil fertility, promotes plant growth and can help in the sustainable management of poultry waste, in addition, its application can reduce the need for chemical fertilizers.

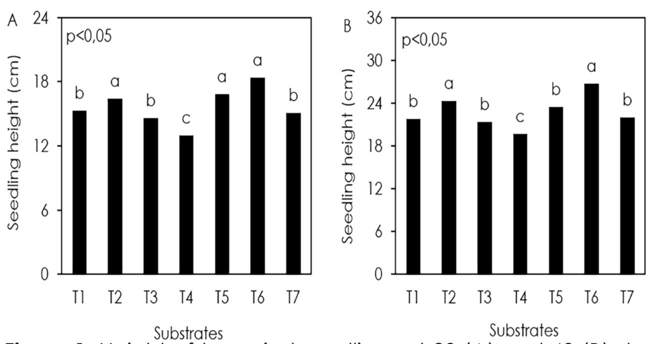

Figure 1: Height of tamarind seedlings at 20 (A) and 40 (B) days after emergence according to substrate types. Means (bars) with the same letter do not differ from each other by Tukey's test. T1: soil (control treatment), T2: soil + cattle manure, T3: soil + sheep manure, T4: soil + chicken litter, T5: soil + cattle manure + sheep manure, T6: soil + cattle manure + chicken litter, T7: soil + sheep manure + chicken litter.

Sperandio et al. (2021) obtained the following result in their research: barnyard bedding improved lettuce cultivation in several crop growth parameters related to topsoil without any type of fertilization, visually there were improvements in the physical characteristics of the soil, such as root growth, which is important for the formation of the shoot.

Figure 2 shows data regarding the stem diameter of tamarind seedlings as a function of the application of swine biofertilizer. It was observed that 40 days after emergence, the seedlings with swine biofertilizer obtained a larger diameter (0,24 cm), while the seedlings without the application of biofertilizer presented a smaller diameter (0.2 cm).

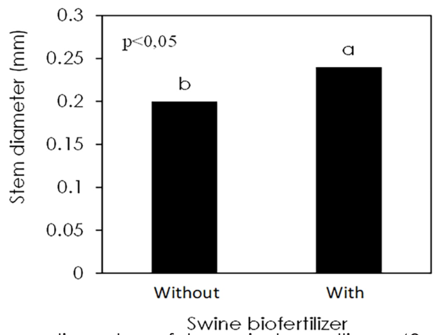

Figure 2: Stem diameter of tamarind seedlings 40 days after emergence as a function of the application of swine biofertilizer.

In Schmitt's research (2021), analyzing the factor "types of biofertilizer" in isolation in lettuce crops, significant results were also presented, with swine manure and biofertilizer having the best results in terms of diameter gain.

Sousa (2018) cited Collard et al. (2001) who found an increase in stem diameter in passion fruit plants with the application of biofertilizer. According to the authors, the beneficial effect of biofertilizer is related to better use of nitrogen from this input by plants, in addition to the presence of phytohormones such as auxins, cytokinin and gibberellin that act on plant growth and development.

Plants with larger stem diameters become more resistant to stem breakage due to pressure exerted by the weight of the fruits or strong winds, or both (Seleguini et al., 2016).

For the number of leaves, the substrate that provided the highest number of leaves, 20 days after emergence, was soil + cattle manure, with 7.97 cm (**Figure 3**A). At 40 days after emergence, the substrates soil + cattle manure (T2) and soil + cattle manure + chicken litter (T6) provided the highest values, obtaining 12.92 and 13.98 cm, respectively (Figure 3B).

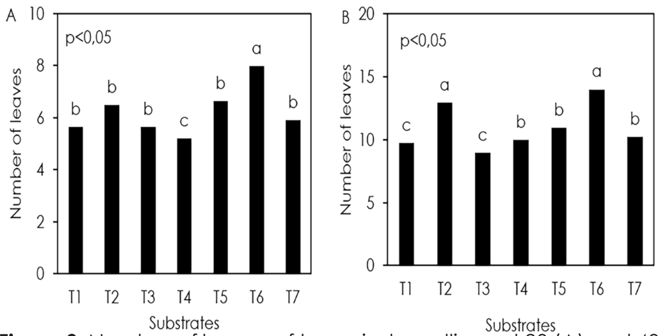

Figure 3: Number of leaves of tamarind seedlings at 20 (A) and 40 (B) days after emergence according to substrate types. Means (bars) with the same letter do not differ from each other by Tukey's test. T1: soil (control treatment), T2: soil + cattle manure, T3: soil + sheep manure, T4: soil + chicken litter, T5: soil + cattle manure + sheep manure, T6: soil + cattle manure + chicken litter, T7: soil + sheep manure + chicken litter.

The number of leaves correlated with the photosynthetic area of the plant, since a greater number of leaves promotes a greater area to capture light energy for the photosynthesis process (Bonfim-Silva et al., 2020).

According to Carneiro & Vieira (2020), cattle and poultry manure are valuable materials for the composition of substrates used in the production of seedlings. These manures provide nutrients, depending on their specific characteristics and compositions, in addition to acting as physical conditioners of the soil.

Cabral et al. (2023) in their research with substrates in passion fruit seedlings obtained the same results for the variable number of leaves which indicate that treatment with soil, sand and cattle manure, followed by treatment with soil, sand and chicken litter, provides better development of the shoot of passion fruit seedlings.

Root dry mass as a function of the application of swine biofertilizer and types of substrates indicated that the substrate composed of soil + cattle manure + chicken litter (T6) with the application of swine biofertilizer promoted the greatest accumulation of root dry mass (**Figure 4**).

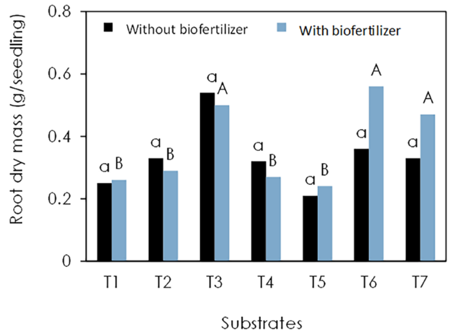

Figure 4: Root dry mass of tamarind seedlings under application of swine biofertilizer as a function of substrate types. Means (bars) with the same letter do not differ from each other by Tukey's test. T1: soil (control treatment), T2: soil + cattle manure, T3: soil + sheep manure, T4: soil + chicken litter, T5: soil + cattle manure + sheep manure, T6: soil + cattle manure + chicken litter, T7: soil +

Because the stem diameter was larger with the presence of swine biofertilizer and in the analyses of seedling height and number of leaves, the substrate composed of soil + cattle manure + chicken litter (T6) performed more effectively, it is therefore believed that because they presented the best behavior, they directly influenced the dry mass of the root.

It can be seen in **Figure 5** that the dry mass of the aerial part of tamarind seedlings under application of swine biofertilizer as a function of substrate types was greater in the substrate soil + cattle manure + chicken litter under application of swine biofertilizer, obtaining 1,16 g.

Souza et al. (2021) concluded that biofertilizer has great potential as an organic fertilizer, as it improves the soil and aids crop growth. However, the potential use of biofertilizers depends on their composition, types, dosages, application methods, and the cultivars used.

It was observed that the root-shoot ratio of tamarind seedlings as a function of substrate types was higher in the soil substrate + sheep manure (T3), obtaining 0,74 (**Figure 6**). According to Figueiredo et al. (2012), when adding carbon-rich organic material to the soil, such as sheep manure, part of it is used by microorganisms as energy, thus promoting increased microbial activity and the consequent release of carbon dioxide.

According to Farias et al. (2021), they concluded that the dose of 40% sheep manure added to the substrate provides greater NFP, DC, MSPA, MSR and MST of the rootstocks in the early dwarf cashew crop.

Root length (**Figure 7**) shows that in almost all treatments a good length was obtained in relation to the use of substrates, the only one that presented lower length was the substrate composed of soil + chicken manure (T4).

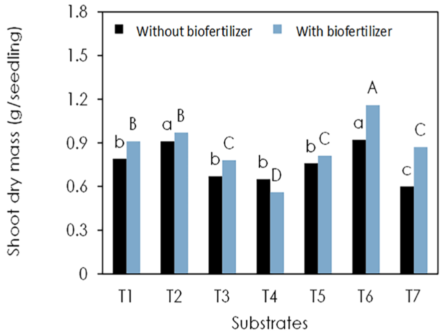

Figure 5: Shoot dry mass of tamarind seedlings under application of swine biofertilizer as a function of substrate types. Means (bars) with the same letter do not differ from each other by Tukey's test. T1: soil (control treatment), T2: soil + cattle manure, T3: soil + sheep manure, T4: soil + chicken litter, T5: soil + cattle manure + sheep manure, T6: soil + cattle manure + chicken litter, T7: soil + sheep manure + chicken litter.

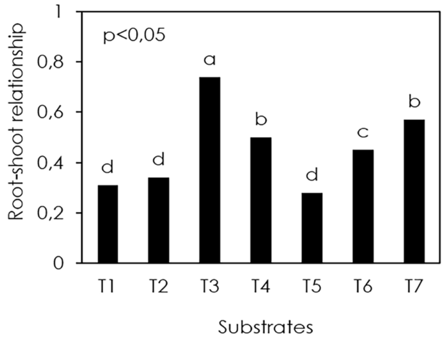

Figure 6: Root-to-shoot ratio of tamarind seedlings according to substrate types. Means (bars) with the same letter do not differ from each other by Tukey's test. T1: soil (control treatment), T2: soil + cattle manure, T3: soil + sheep manure, T4: soil + chicken litter, T5: soil + cattle manure + sheep manure, T6: soil + cattle manure + chicken litter, T7: soil + sheep manure + chicken litter

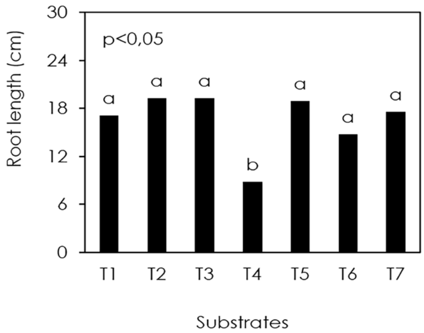

Figure 7: Root length of tamarind seedlings as a function of substrate types. Means (bars) with the same letter do not differ from each other by Tukey's test. T1: soil (control treatment), T2: soil + cattle manure, T3: soil + sheep manure, T4: soil + chicken litter, T5: soil + cattle manure + sheep manure, T6: soil + cattle manure + chicken litter, T7: soil + sheep manure + chicken litter.

According to Bottrel et al. (2023), the direct use of poultry litter from the poultry house can cause serious environmental and agronomic risks, the high concentration of N-ammonia can lead to soil contamination, harming the microorganisms responsible for the transformation of nutrients, in addition, there is a risk of leaching, causing pollution of groundwater and watercourses, and eutrophication of nearby water bodies, compromising soil fertility and water quality.

Saldanha & Ribeiro (2021) stated that it is essential to analyze the influence of different doses of the compost on the development of specific crops. The other substrates, because they were well composted, or had a small amount of chicken litter substrate, managed to obtain a higher average.

Conclusions

The best combination of substrates for seedling production was soil + cattle manure + chicken litter.
The application of swine biofertilizer to tamarind seedlings promotes beneficial effects on stem diameter, thus making seedlings stronger and more resistant. The production of tamarind seedlings was benefited and observed to be a viable option with the use of substrates and swine biofertilizer, promoting greater expansion in commercial cultivation of this fruit.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.